Supplemental Specification
2005 Standard Specification Book

SECTION 02455

DRIVEN PILES

Delete Section 02455 and replace with the following:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials, equipment and procedures for driving steel piles.

1.2 RELATED SECTIONS

A. Section 03055: Portland Cement Concrete

B. Section 03211: Reinforcing Steel and Welded Wire

1.3 REFERENCES

A. AASHTO M 31: Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

B. AASHTO M 270: Structural Steel for Bridges

C. ASTM A 252: Welded and Seamless Steel Pipe Piles

D. ASTM D 4945: High Strain Dynamic Testing of Piles

E. AASHTO/AWS Welding Specifications

1.4 SUBMITTALS

A. Complete and submit the "Pile and Driving Equipment Data" form located at the end of this Section for each proposed hammer and pile/structure combination.
   1. Provide all data in the form necessary to perform a pile driving wave equation analysis, together with preliminary schedule for driving.

2. Within 14 calendar days of submitting the form, the Engineer will provide either:
    a. Approval to continue
    b. Notification of inadequate equipment

B. Include manufacturer's product data, specifications, and recommended installation instructions for the submitted pile hammer.

PART 2 PRODUCTS

2.1 PIPE PILE SHELLS

A. Use new pipe pile shells having wall thickness as shown on plans.

B. Meet requirements for ASTM A 252 steel, for either Grade 2 (normal strength) or Grade 3 (high strength) steel, or for other minimum yield stress value(s) shown on the plans.

2.2 STEEL HP SECTION PILES

A. Follow AASHTO M 270 for Grade 36 or 50 steel, as specified in the plans.

2.3 PORTLAND CEMENT CONCRETE

A. Class A(AE) Concrete following Section 03055.

2.4 REINFORCING STEEL

A. Meet AASHTO M 31, Grade 60.

B. Follow requirements in Section 03211.

2.5 PILE DRIVER

A. Verify the equipment can drive piles to the required ultimate driving resistance without damage or without requiring an excessive number of blows to achieve the required tip elevation and capacity before mobilizing pile driver to the site, in accordance with this Section, article 1.4, paragraph A.

B. Mobilize pile driver to the site only after the Engineer indicates that acceptable results of the wave equation analysis have been obtained in accordance with this Section, article 1.4, paragraph A.

C. Remove any mobilized pile driver and related equipment found to be inadequate for the project pile driving conditions, and repeat the requirements of this Section, article1.4, paragraph A until an acceptable pile driver system is obtained.
   1. Re-mobilize the accepted hammer at no cost to the Department.

D. Provide accurate test information regarding the yield stress values (heat) for each batch of piles to be used on the project.

E. Equip pile driver following Manufacturer's recommendations.

F. Leads:
   1. Used with all types of hammers.
   2. Hold in the required position with guys, stiff braces, or both.
   3. Hold the pile parallel to the leads.
   4. Accommodate the maximum length of the pile segment, and extend to the lowest point that the hammer must reach.
   5. Obtain approval from the Engineer before using followers.
   6. Use fixed leads if necessary to maintain required driving tolerances described in this Section, article 3.3, paragraph C.

G. Drive Cap (or Drive Head): Fits the top of pile and provides full bearing. For pipe piles, drive cap to have a machined surface to fully engage the end of the pipe.

H. Hammer:
   1. With fully operable adjustable settings.
   2. Rated energy greater than or equal to the value indicated on the foundation plans.
   3. Inspect hammer cushion with the Engineer present before beginning pile driving and after every 100 hours of pile driving. Replace the cushion when it loses 25 percent or more of its original thickness.

PART 3 EXECUTION

3.1 PREPARATION

A. Complete all foundation excavation before driving piles.

B. Dewater excavation at least 1 ft below bottom of foundation at all times during pile foundation operations.

C. Notify the Engineer of any conflicts between the designated position of piles and the locations of existing piles from previous construction, existing utilities, old foundations, or other potential conflicts. The Department designates new pile locations as required.

3.2 DYNAMIC ANALYSIS OF PILE DRIVING

A. Notify the Engineer at least five working days before pile driving is to begin on the project, and at least five working days before piles are to be driven on all subsequent abutment and bent foundations.

B. The Department (or a Department authorized geotechnical firm) conducts at least one high-strain dynamic test (in accordance with ASTM D 4945) per foundation (abutment, bent, or pier foundation). The Department performs this test using pile driving analysis (PDA) equipment on the driving of the first pile at each abutment and bent/pier foundation.

C. Cooperate with the Department in conducting PDA including, but not limited to, the following:
   1. Provide adequate space and conditions for the PDA rig and equipment.
   2. Climb the driver leads as necessary to attach, check and remove PDA gages; or provide a platform at least 4-foot square with a 4-foot high safety rail, equipped to be raised to the top of the pile located in the leads, to allow personnel to safely attach and remove gages.
   3. Begin installation of dynamic analysis gages after placing the pile in the leads. Allow approximately one hour per pile for installation of dynamic measuring equipment. Allow one additional hour for installation of measuring equipment after splicing, if splicing is performed and additional testing is required.
   4. Reduce the energy of the hammer or make other adjustments as necessary, if the stress exceeds the specified limit during the test.
   5. Drive the pile until the test indicates the required driving resistance shown on the plans is achieved, unless otherwise indicated by the Department.

D. The Department evaluates the driving resistance, and establishes driving criteria, using a wave equation analysis program with signal matching.
   1. Do not drive other piles in the foundation until the Department gives notice that the test results indicate that sufficient capacity has been obtained, and the driving criteria for the remainder of the piles in the foundation has been established.

E. If sufficient capacity is not obtained on initial drive testing, perform a restrike PDA test on the pile after a sufficient time period (generally 24 or more hours after the initial driving of the pile).
   1. Do not perform restrikes using a cold hammer.

F. Notify the Engineer if any of the remaining piles in the foundation do not meet the established driving criteria before moving hammer away from bent/abutment area, or if driving conditions otherwise change.
   1. The Department may require testing additional piles and reestablishing driving criteria for the remaining piles within the foundation.

3.3 PILE INSTALLATION

A. Pre-drill/pre-auger if the designated pile tip elevation cannot be reached by the approved pile driver.
   1. Do not drill holes greater in diameter than the diameter or other maximum dimension of the pile.

B. Pile Splicing:
   1. Use no more than one spliced section less than 6 ft, and splice no other section less than 30 ft for any pile.
   2. Inspect the driven pile section before splicing any pile section to determine if it has been distorted from its original shape, or otherwise damaged from pile driving operations.
      a. Remove the damaged portion where distortion/damage has occurred, before splicing the next segment.
   3. Splice new pile segments parallel with previously driven pile segments.
   4. Butt weld the entire pile cross section using full penetration welds as per AWS D.1.1 for pipe piles and AASHTO/AWS D.1.5 for HP section piles.

C. Keep driven piles within 6 inches of the designated plan location, and within 2 percent of vertical (plumb) throughout the total length of the pile (including bending). This is roughly equivalent to ¼ inch in a foot, or 0.60 inches in 30 inches.
   1. Verify that these criteria have been met, including using a calibrated pile bending probe where necessary, at the end of pile driving before proceeding with backfilling or other associated foundation work.
   2. Notify the Department to determine the appropriate resolution if either requirement is not met.
   3. Contractor bears all costs for any measures required to resolve the non-conformance including the price reduction factors shown in Table 1 in this Section, article 3.5.

D. Drive additional piles as required to replace damaged piles and piles driven out of plumb, or plan location at locations designated by the Engineer.

E. Drive down piles that were raised due to driving adjacent piles.

F. Notify the Department of water collecting in open pipe piles so that they can be evaluated for possible damage.
   1. Drive additional piles as described above and abandon damaged piles as directed by the Department as necessary to resolve concerns with pile damage.

G. Cover open-ended pipe piles to prevent the collection of precipitation, other sources of water, or debris.

H. Cutting and Capping Piles:
   1. Remove all damaged material from the top of the piles.
   2. Keep sides of piles at least 9 inches away from nearest edge of pile cap.
   3. Cut off piles with clean, straight-line cuts to the designated elevation at a right angle to the pile axis.
   4. Level all irregularities before placing concrete for pile cap.

I. Fill any annular space between the pipe shell and the surrounding soil with grout or clean sand washed down to reestablish lateral support.

J. Remove all loose and displaced materials from around the completed piles leaving clean, solid surfaces to receive the concrete.

K. Level all irregularities before constructing pile cap.

3.4 CONCRETE FILLING OF CLOSED-END PIPE PILES

A. Remove water and debris from pipe piles before filling with concrete.

B. Receive approval from the Engineer before concrete placement in pipe piles.

C. Fill pipe piles with specified concrete after compliance with all tolerances and required criteria have been confirmed by the Engineer.

D. Avoid segregation of the concrete ingredients.

E. Slump at the time of placement: between 4 and 6 inches.

F. Arrange chutes, pipes, etc. used as aids in placing concrete so concrete does not separate (i.e. flows freely without having to be pushed or shoveled).

G. Place concrete in pipe shell either by free fall, or through a tremie, drop chute, or concrete pump.

H. Place concrete to the base without contacting either the rebar cage or the pipe wall.

I. If a hopper or concrete bucket is used, discharge concrete into a funnel-type downpipe centered over the hopper or bucket.
   1. Do not discharge concrete directly from the mixer into the hopper or bucket.

J. Use high frequency internal vibrators to consolidate concrete to at least 3 ft below the bottom of the rebar cage, or to at least 13 ft below the pile cutoff level, whichever is deeper.

K. Do not vibrate concrete that has taken initial set.

L. Vibrate concrete again after inserting cage to eliminate voids around the cage if rebar cage is inserted after concrete has been placed.

M. Place the reinforcement cage into the driven pipe pile when the concrete reaches the planned bottom elevation of the reinforcement for piles larger than 16 inches in diameter.
   1. Support the reinforcement so it remains within 2 inches of the required vertical location.
   2. Support the cage from the top until the concrete reaches the top of the pile.

N. Secure rebar cage in position until concrete is set.

O. Provide lighting to the work site if concrete placement is to occur after daylight hours so all operations are plainly visible.

P. Embed the tops of piles in the concrete pile cap as shown on the plans.

3.5 PRICE REDUCTIONS FOR NON-CONFORMING WORK

A. Price Adjustment - Reduction for Deficient Strength Concrete:
   1. Consider acceptance for concrete in pipe pile shells that are below the specified strength according to this Section.
   2. The Department will:
      a. Use Contractor’s unit bid price and the pay factors schedule presented in Section 03055 to calculate the price reduction for compensation.

b. Evaluate concrete with a compressive strength deviation of more than 400 psi below the specification, to determine capability of the material to maintain the integrity of the concrete-filled pipe pile.
   1) Provide acceptance for:
      a) A 50 percent pay factor or
      b) Direct another pile driven at a suitable location adjacent to the deficient pile.

B. Price Adjustment - Reduction for Out-of-Tolerance Piles:
   1. Demonstrate technical adequacy for piles driven out of plumb or plan location.
   2. The Department will:
      a. Accept piles according to this Section, article 3.5.
      b. Reject any pile driven outside the upper deviation limits shown in Table 1 below.
         1) No payment made for the rejected pile.
      c. Use the Contractor's unit bid price and the pay factors schedule presented in Table 1 to calculate the price reduction for compensation.

Table 1

PRICE REDUCTION PAY FACTORS FOR NON-CONFORMING PILE DRIVING TOLERANCES		
Pay Factor	Plumb, % (deviation from 2.0 %)	Plan Location, in. (deviation from 6 in.)
1.00	0.00 to 0.40	0.00 to 0.75
0.90	0.41 to 0.80	0.76 to 1.50
0.80	0.81 to 1.20	1.51 to 2.25
0.70	1.21 to 1.60	2.26 to 3.00
0.50	1.61 to 2.00	3.01 to 3.75
0.30	2.01 to 2.40	3.76 to 4.50
0.10	2.41 to 3.00	4.51 to 6.00
0.0, Reject	> 3.00	> 6.00

C. The Department will:
   1. Apply pay factors to each pile individually based on the total measured pile length from the specified cutoff elevation.
   2. Apply only the most critical of the two criteria (i.e. having the lowest pay factor) for any one pile.

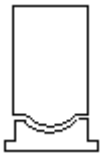
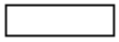
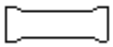
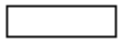
END OF SECTION

The recommended "Pile and Driving Equipment Data" form follows.

Sheet # _____

Pile and Driving Equipment Data

Project No: _____
Project Name: _____ County: _____
Drawing No: _____
General Contractor: _____
Pile Driving Contractor/Subcontractor: _____
Phone: _____ FAX: _____
(Piles driven by, foreman): _____
Date Submitted: _____

Hammer Components		**Hammer**	Manufacturer: _____ Model: _____ Type: _____ Serial No: _____ Manufacturer's Maximum Rated Energy: _____(k-ft) Stroke at Maximum Rated Energy: _____(ft) Range in Operating Energy: ____ to ____(ft-k) Range in Operating Stroke: ____ to ____(ft) Modifications: _____
		Ram	Ram Weight: _____ (lbs) Ram Length: _____(ft) (for diesel hammers)
		Anvil	Ram Cross Sectional Area: _____(in^2) (With diesel hammers) Anvil Weight: _____(lbs)
		**Hammer Cushion**	Material #1 Material #2 Name: _____ _____ Area: _____ _____ (in^2) No. of Plates: _____ _____ Thickness: _____ _____ (in) Mod. of Elasticity - E: _____ _____ (psi) Coeff. of Restitution - e: _____ _____
		**Drive Cap**	Helmet Weight: _____(lbs) Bonnet Anvil Block Drive Head
		**Pile Cushion** (Only for Concrete or Timber Piles)	Material: _____ Area: _____ (in^2) No. of Sheets: _____ Thickness/Sheet: _____ (in) Total Thickness of Pile Cushion: _____ (in) Mod. of Elasticity - E: _____ (psi) Coeff. of Restitution - e: _____
Pile		**Pile**	Diameter: _____ (in) Wall Thickness: _____ (in) Taper (if any): _____ Length in Leads: _____ (ft) Ordered Length: _____ (ft) Required Driving Resistance: _____ (kips) Description of Splice: _____ Tip Treatment/Plate Description: _____

Use Separate Data Sheet for Each Proposed Hammer and Pile/Structure Combination